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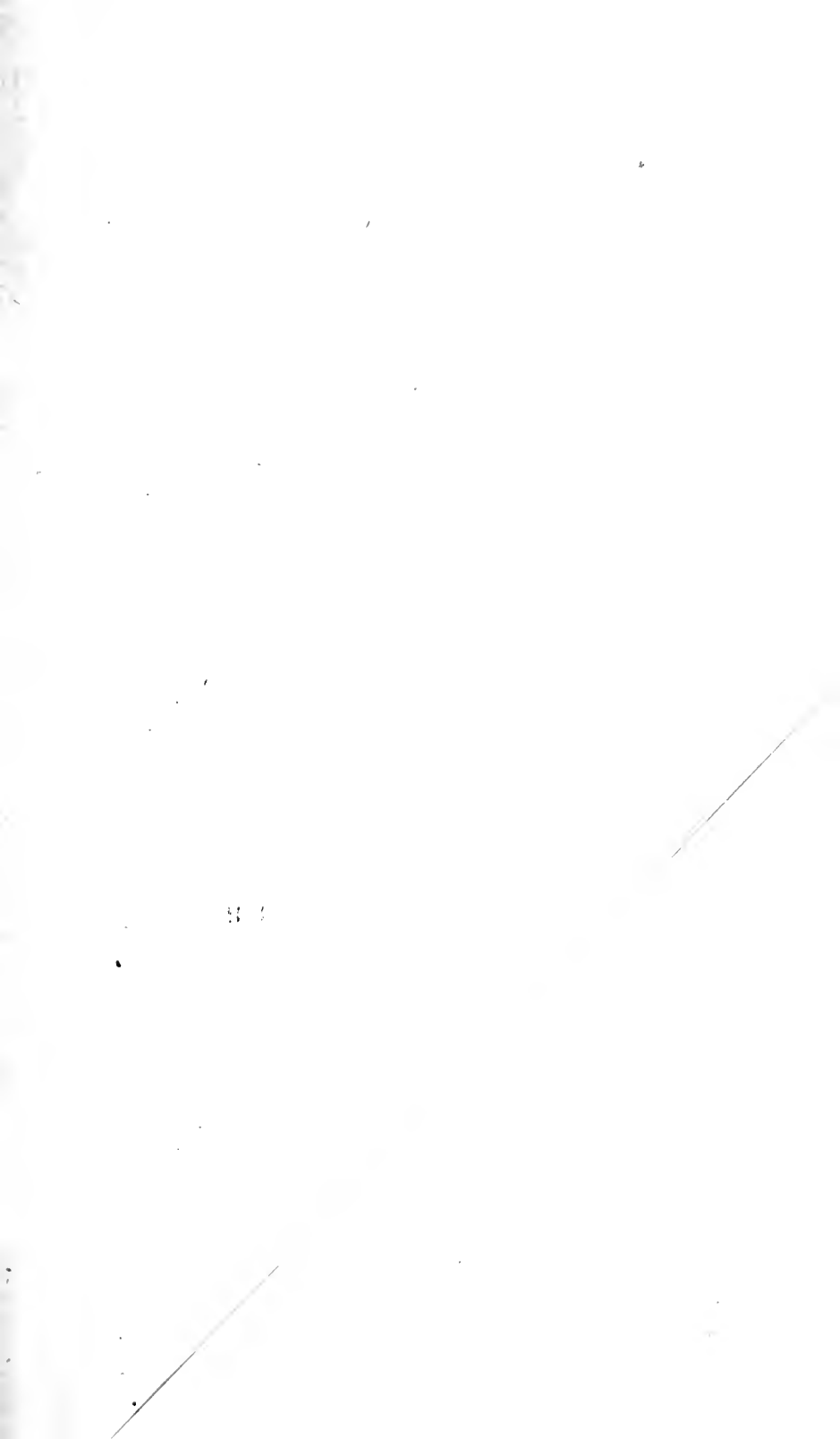


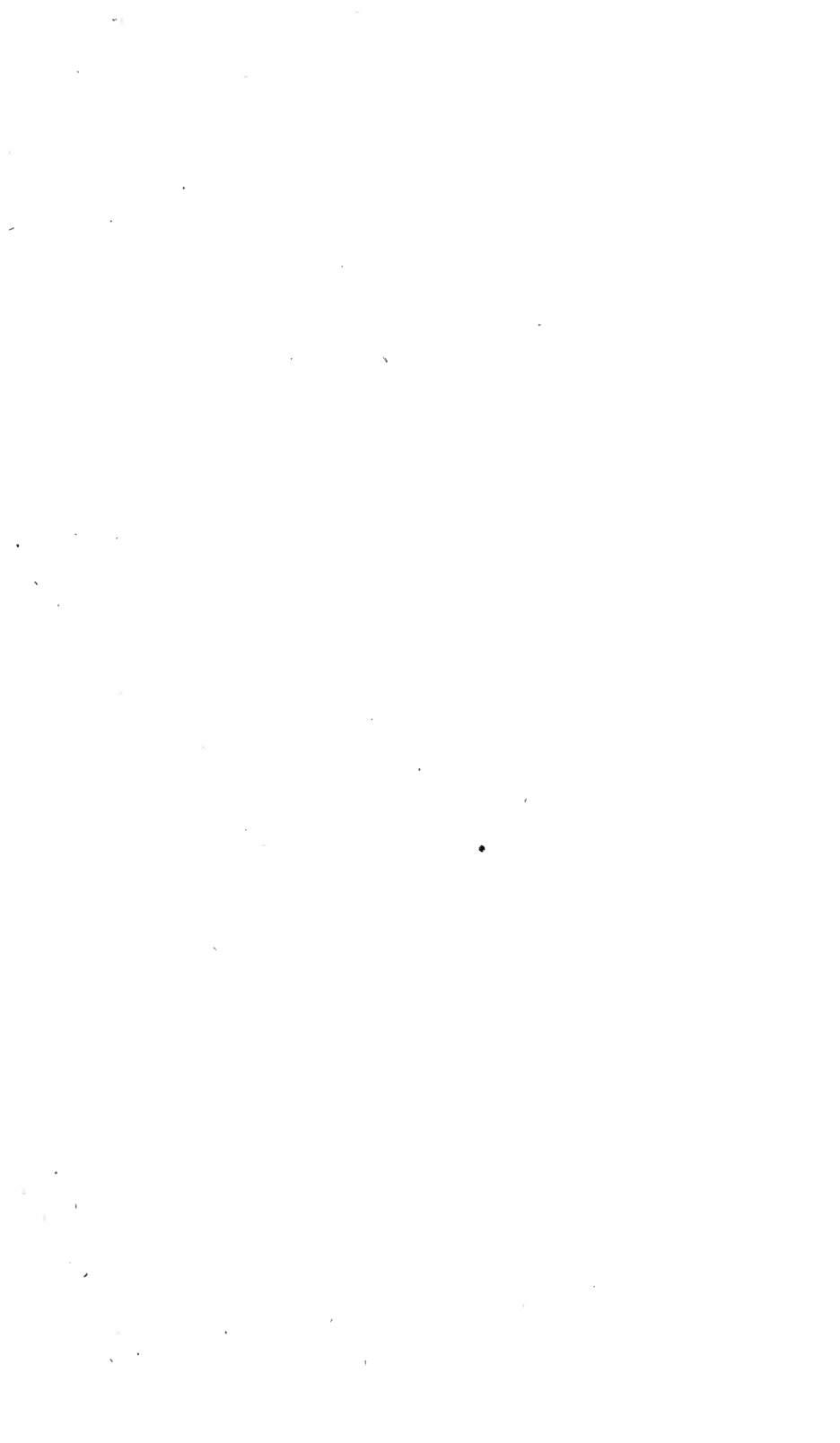
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SECTION OF ROAD AS BUILT BY JAMES OWEN, C. E., IN NEW JERSEY, U. S. A.

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ADDRESS

ON THE

Highway Construction

IN

NEW JERSEY, U. S. A.

BY

JAMES OWEN, CIVIL ENGINEER,

MONTCLAIR, ESSEX COUNTY,

N. J.

SALEM, MASS.:
SALEM OBSERVER BOOK AND JOB PRINT.
1893.



ADDRESS.

Probably no one question enters more intimately into the daily life of civilized humanity than that of roads : by the term roads I speak generally, be they good, bad or indifferent, and as a highway is an essential element in civilization, so their condition represents the environment of the inhabitant influenced by its proximity. The daily life, the food, the habits, and health are all governing influences on mankind in general, and each of these influences is affected for good or bad by the excellency or inferiority of the roadway which each individual of any community has to use, should use, or can't use.

It may be therefore stated as an axiom that the higher the civilization the better the roads ; while exceptions to this may occasionally be noted, they are so rare, as to little affect the general principle.

The people of the United States primarily have accepted and fulfilled one obligation of their citizenship and that is the opening of means of communication between the settlements made and each individual of the community whether far or near, the proper maintenance of such communications has not been considered of much paramount importance, or rather of such importance as to warrant more expenditure than the most niggardly requirements might demand. The result is that roads that have been in existence one hundred and two hundred years and roads of more recent creation, are practically in the same condition to-day as they were at their initiation, if anything, worse.

The problem that faces the inhabitants of this country to-day is the betterment and improvement of these high-

ways, not in a hap-hazard, spasmodic way, but with a system based on the knowledge of what to do and how to do it, based on a conception of the immensity of the task imposed and the enormous outlay involved, and with a resolution of giving the people a dollar's worth of road for a dollar invested. In fact, to do the work properly and economically with a due regard both for the present outlay in construction and the future expenditure in repairs.

It has been my lot to have been engaged in the conception, growth and fulfilment of a system of roads in New Jersey, and while I may point with considerable satisfaction at the result of my labors, and at the same time say to all who wish to examine them, there they are, look at them, they speak for themselves, yet I do not wish to arrogate to myself anything more than trying to do my best in that branch of surveying it was my fortune to experience. Faults were made. Experience had to be had and I trust that the faults and experiences will deter and guide others who follow from the same sins of omission and commission.

At the time that I individually became interested in the road movement in the State of New Jersey, which was about the year 1868, the condition of the roads at that time in the State was simply a parody on means of communication. What is known as the traditional Jersey Red Mud, dry in summer, muddy in fall and spring, and impassable in winter, existed around the northern part of that State almost universally; and while there was an under current in existence at that time, and had existed for a number of years, of a feeling toward the betterment of these roads, it failed for any outward or positive expression. By a curious analogy, if it may be so called, the movement sprang up to counteract a movement for entirely another object. The construction of the Central Park in New York City, and Prospect Park in Brooklyn, led a few of the enthusiastic admirers of such work to seek for

legislation for the construction of a park in the city of Newark (Newark being only 9 miles away from the city of New York and practically a component part thereof). The sober business men of the city thinking that a park was a luxury, deeming good roads a necessity, put their heads together and had a law passed, which was practically the pioneer law of this section, and we might say of the country, authorizing the appointment of a commission for the construction of certain roads in the county, and which was known as the Essex Public Road Board Law. By the passage of this law it would seem that there would be a clear field for some progress, but public sentiment was not then ripe for any such general movement; protests were heard on all sides, the county authorities upon whom devolved the power to issue money sat down completely on the subject, and meetings were held in all the different towns and cities of the county to protest against the movement, and in deference to what was seemingly then an overwhelming sentiment, the commissioners confined themselves in the first year to formulating a general plan of improvement which they hoped might be carried out in the future. The next year, the pros and cons in the meantime having been well discussed, a promising report of the proposed improvements having been laid before the community, there seemed to be then a change of sentiment prevailing more in the community in favor of something being done. The original law of 1868 was amended, its defects having been pointed out by contests in courts, and instead of general powers being granted the commission for locating and building roads wherever they in their wisdom, or caprice as some say, might build them, the legislature passed an act defining six main thoroughfares leading from the city of Newark in all directions, as the limit and scope of the work of the commission. The law being fairly settled and crystallized, public excitement having been allayed and sound second thought then prevailing, the

commissioners feeling that they had a backing behind them went to work and constructed the system of roads as outlined by the law, and as shown on the map I have here before me. By looking at that map it will be seen that all parts of the county would be fairly well accommodated by the proposed routes, and as the result has shown they were well accommodated. It must be understood though at this time, that the question of hard roads had not then entered into consideration. The powers of the Essex Road Board at that time limited them to opening, widening, straightening, and then constructing them merely as dirt roads; this was at any rate a vast improvement on the existing roads, as they were mostly narrow, mostly crooked, and with no established grade and very little drainage. Subsequently legislation was had, and powers were given to the Board to pave with the Telford process. I wish here to note that point particularly, as at that time the question of macadamizing (and I mean by macadamizing, making a thin pavement) was not raised, and no thought was given to it. So, after a considerable number of miles of avenues had been graded and power obtained to Telfordize, the commissioners started to pave these roads, and as years passed on these roads were paved, and the whole system with one or two exceptions as outlined on the map, were completed and built. The reaction in trade, and the depreciation of property in the period between 1875 and 1880, well nigh absolutely stopped the work, put a damper on the enthusiasm of real estate owners and progressive men generally, and slow progress was made during that period. After 1880 a counter reaction having set in, the work was resumed more vigorously, and by 1885, the whole system was practically completed. I presume it would be in order here to allude to and describe the mode of construction of this work, though it can hardly be considered as the general course for future adoption by all communities proposing to avail themselves of good roads, as the work contemplated

not only main arteries of communication, but provided for the development of the property along those lines of communication ; combining, you may say profit on land, as well as the profit by better travelling ; yet it may be interesting to know what was done for that purpose. The width of these roads varied between 80 and 100 feet. It may be said here that none of them are called roads, but all avenues, and they were in the strict sense of the word, avenues. The grades were established under the idea that they were to be arteries of travel ; the local consideration of ground and fitness for building were made secondary, and ease of communication and travel primary. This necessitated of course a much larger amount of work, and more expenditure of money than would be wise or proper in the ordinary improvement of public highways throughout the country.

So the grading on that basis having been completed, thus forming a nucleus for future improvement, the Telfordizing was proceeded with. It was seen at the onset, and a law was so framed that as the county itself paid the larger proportion of this work, and as the travel on almost every road is mostly in the centre, that if the county provided a certain width in the centre, that would be all that would be required for the ordinary travelling public ; if at any time the residents or communities should require the full width of the pavement, power was given for it to be done, but the owners of the property themselves were to pay for it. On starting the pavement in question the problem of widths having been decided as twenty feet by law, the other question of thickness being mainly engineering, received consideration. As previous to 1868, my experience on road work had been confined to what may be called extra priced work for extra excellence in results, it was hardly considered wise to start on an extra and improper, if it may be called, allowance or expenditure of money ; how far to get down, and what limit to arrive at in this thing,

was at this time an unknown problem. The Jersey Red soil, known for its treachery, the difficulty of handling and constructing the work, the lack of experience in similar work of the kind through similar soil, made the decision one of a great deal of moment. However, after due thought, it was decided to build the main avenues of the county twelve inches thick on the Telford plan, eight inches of foundation, and four inches of broken stone. The result of this work shows that the plan then outlined and followed proved to be successful; in no case in the many miles of county roads built under my supervision have I had to take up and relay any part or portion thereof. Their condition is uniformly good. Subsequent experience and investigation, and more thorough study of locality and peculiarities of soil, have shown that even this thickness may be advantageously lessened, and to-day I am in no case, except under very peculiar circumstances, building roads of a greater thickness than eight inches on the Telford plan; and I wish to lay before this meeting very emphatically that my idea of a standard road for all ordinary highway practice and purposes in this country, should be an eight-inch Telford pavement consisting of five inches of foundation, large stone, and three inches of broken stone on top; a departure from this in either direction should be resented if possible. In very few cases, except thickly settled communities, is there any necessity for an extra thickness. In other cases after due consideration, both of the topography, and the geological formation of the country through which the road passes, a thinner thickness might be considered advisable and economical; but to that lessening of thickness I would put a veto at six inches. It may be considered that probably I am a little narrow in my ideas of this work, and perhaps I am, but I can stand before any community and say to them "if you build your roads between six inches and eight inches in thickness, you can have good roads at all times and under all circumstances

with the least amount of money for maintenance and repairs." I allude to this point more particularly here, as throughout the country to-day there is waging a war, as the war was waged in England fifty years ago, between the advocates of the thick pavement known as Telford, and of the thin pavement known as Macadam.

In reading a paper a few months back before the Societies of Civil Engineers, I brought up this question of thin or thick pavement, and the words I said then and I would say here, as they are words that I still adhere to and may be well quoted now. I said: "The statement might as well be made here, that the writer (that is myself) is unqualifiedly in favor of thick pavements with a foundation, and opposed to thin pavements of broken stone. His early experience having been entirely with Telford pavement, he might be accused of prejudice, but since the controversy on the question has arisen, he has built miles of thin pavement, and the result of his experience in such work is, he will sin no more. As has been stated, varying climatic conditions enter into the question, which render nugatory previous experience in foreign countries, and the road construction in the United States will have to be undertaken from experience derived from its climate and soil, and their peculiar requirements and exigencies. It is proper to concede at once, that in districts where the soil is gravelly or sandy, thin Macadam roads may be used with success and economy. The area of gravel or sandy formation in the whole country, however, necessarily limited, and a practice that is a success with such a soil, would be at least open to criticism in the bottomless mud of the Ohio Valley. All that section of the United States south of an isothermal line (if one could be constructed) with the limit of frost entering the ground to a depth of eight inches, might be considered a fair field for thin pavements, subject, of course, in such localities, to the possibility and necessity of good drainage, as well as a systematic comparison of the cost of said drainage as

against the increased cost of the insertion of the pavement. In all mountainous countries, necessitating grades of over four per cent., thin pavements can be judiciously used ; but as in such districts the prevalence of stone immediately at hand, would probably offset such a requirement, it would be more economical to build a thick road with a foundation of local stones than to haul broken stone from a distance." If the experience of other States is any guide to what the State of Massachusetts will undergo, the same problem will arise before you, and in discussing that problem, we have to consider as a potent factor, public sentiment, and ideas of the communities through which these roads pass, and in all probability by whom the bills for their construction will have to be paid. The public idea of expenditure of money varies so greatly in different communities, that it will be a matter of immense work and industry to educate them all to a common and proper standard. People in cities are educated to the expenditure of public moneys to a degree that might be not improperly called wasteful ; the people of a farming community are educated on the other hand to a standard of expenditure which might be called parsimonious, the result of both is a waste of money, if carried out to its extremity. The waste of money on pavements in cities is notorious, and I do not know that the cities of Massachusetts can be considered exempt from such a practice : yet, with the existing ideas as I said of the expenditure of moneys in cities, extravagance will naturally arise. To harmonize these conflicting ideas will and should be the object of the Massachusetts Society for Promoting Agriculture, under whose auspices this meeting is held.

If roads are constructed on the basis that I have suggested, with uniform standard and work, it will give you all that you want, but you will be met by the inhabitants of the larger towns and cities crying for something wider and better for their particular and specific purposes, and you will be met by the farming community, asking for an ex-

penditure of the money in such a way that it may go as far as it will at once, leaving the problem of future maintenance and the raising of the money for such future maintenance, to the future. I have in mind to-day two counties in New Jersey in which the practise is so diverse, and so opposite, that it would be interesting to notice it. Both have recently started on a system of improvement of their country roads, both acting under the same law, and yet the practise is so diversely opposite, that it can hardly be realized that a distance of twelve miles separates them, instead of a hundred and fifty or two hundred that might be allowable for the lack of the spread of the information necessary. One county (and I would say here I am not interested in either of the two, so that I can criticise fairly)—one county started the practise of building thick, solid foundation roads throughout its length and width; the roads are excellent, the results of their improvements are also excellent, but when these roads were once done, the thought of repairs never entered their heads, and the consequence is, while they were originally good, if no action is taken in the near future, they will be remarkably bad. The other county started out with a system of thin roads, abnormally so, I call it, presumed to be four inches thick, but in many cases less; the result of that has been that they have been able to extend their road improvements to the extreme limits of the county. The frost of winter broke it up and blew it up, and a system of repairs had to be initiated almost before the completion of the original work. Accepting the matter as inevitable, they started on that system of repairs, and keep it up, and the county authorities accept it as a fact and pay the money, although in the end the amount of the annual expenditures for repairs will be vastly in excess of what it would be for good, solid construction at first; but they have got their roads, and you will find in your State the same arguments, and same influences brought to work. In my own county, in the local townships that are improv-

ing their roads under their annual appropriations, the same influence is at work ; and to my mind, it is to be regretted, and one of the road problems that will confront engineers, and perplex them to a great degree, is the crystallization of practise in road construction, to enable every community to obtain the most economical results. Taking the stand I have in road construction, I now resolutely deny myself the privilege of supervising any work that I think will not bring good result in the future, and in doing so, I feel that while it may be some sacrifice at present, it will be of advantage to me in the future, and I know it will be to those who follow my advice. It might be expected that the purely engineering part of the construction of roads may not be interesting to this meeting, yet it occurs to me that it will not be out of place for me, as an engineer, to allude to the attending engineering problems and practices that I have met and followed in the construction of the highways, and avenues in New Jersey.

I will take these engineering problems of road improvement as they naturally occur.

To commence with, as to grade, it may be asserted that no road should ever be built on a level grade ; and, in my experience, no grade should ever be less than six inches in one hundred feet, as much more as you can possibly get, up to twelve inches in one hundred feet, which is probably the most suitable grade for highways, and gives a free and proper flow to the surface-water from and off the road itself. Wherever water stands in a roadway of any kind (except, of course, city pavement), it has a tendency to disintegrate the material of which it is made, making it soft and easily influenced by the travel upon it. The result is either ruts or holes, both an abomination to travellers ; but the ruts are worse. The hole is probably occasional, but the rut stays along with you, and whenever a rut is started, each ensuing traveller makes it his business to run in it, enlarge and keep it up, as a friend

not to be parted with. By a proper grade, then, to your road, you eliminate one source of trouble, namely, standing water. The extreme steepness of roads is, of course, dependent upon its location. A grade of four feet in one hundred is the limit of good, easy travelling, and anything steeper than ten feet in one hundred should not be allowed, and that grade should only be permitted in exceptional circumstances. The custom of having grades of thirteen to fifteen feet in one hundred in mountain roads, is a bad one, and is due to the haste the originators had to get there, wherever it was, and a few extra miles in the length of many mountain roads would have saved many thousands of dollars in horseflesh, and obviated many impressive remarks by the travellers struggling up and stumbling down; and it would be in order here to suggest that in the proposed improvement in the roads of your State, this one point be taken into consideration, and the very bad grades be eliminated even at a present extra outlay of money. But in all establishments of grade, make the standard limits between one and four feet in one hundred, and you will always have satisfactory results.

Incident to the grade of the road is the shape of its unfinished surface, known generally under the name of its crowning or rounding. Good judgment and experience are more required on this one point than in any other question of road-building. If the road is too flat, the water will not run off properly, and ruts are formed. If there is too much crowning, the travel all concentrates in the centre, and ruts are occasioned in that way. If these ruts are on a steep grade, the water follows them instead of running to the sides of the road, and tears out the material. Another point should be remembered, that a road should be constructed with an inch to a half-inch more crown than is permanently designed for it, as the bulk of all travel is in the centre, and this would settle the centre more quickly than the sides. The writer's exper-

ience is that a crown of twelve inches in a thirty-foot road, settling to ten inches soon after completion, is about the desideratum. An extra allowance of two inches should, however, be given to grades steeper than five feet in one hundred feet to shed water more quickly, and on all steep grades, breaks or thank-you-marms should be put in about four hundred feet apart, to make the shed doubly sure.

On the matter of proper drainage, I would lay especial stress. Of course, I do not suggest in the construction of these proposed State roads that an elaborate system of underdrainage should be undertaken, but I do insist that under certain circumstances and certain conditions, money spent in properly removing accumulating waters is money saved.

In ninety-nine cases out of a hundred it is cheaper to dig or ditch, to drain a hole, or pocket or swamp, than it is to fill the place up, yet to my knowledge, money, time, and energy have been wasted in filling with stones and boulders wet and low places in roads, with still unsatisfactory results, when if one-tenth of time and energy had been consumed in draining these same places, permanent success might have been insured. In one particular case, I remember, on a road that had been travelled for over one hundred years, and during that period, stones and boulders had been dumped to keep teams and loads from getting mired, on my proposition of lowering the grade of the road and removing these stones, I was solemnly assured of the folly of such a proceeding and undoing a century's work. The result, however, proved the contrary, as a good road has existed ever since the new grade was made.

What I would suggest, however, in the general drainage is that with proper grades, care should be taken to shed the water thoroughly at the low points, and if the grades are long, also at proper intermediate points. Where

quicksand is struck, or soft, boggy ground, special provision must be made to avoid permanent and unceasing repairs. Quicksands can always be permanently treated by proper drainage, but bogs and swamps of large area cannot usually be so handled. The use of brush and similar material is best to make usually a permanent road.

Incidental to the crowning and grades is the proper surfacing of earth for the reception of the road material. Under all circumstances and at all times should the surface of the ground be similar to the finished surface of the roadway, with proper shoulders to hold the material in shape. No dumping the broken stone haphazardly on the existing uneven surface and then spreading it to make the top uniform. This never will, never has made a good roadway, and it is an essential element for successful results in road-making to dig out to the depth necessary, to trim off with a proper crown, and then put on your stone.

The next problem for consideration is the material to be used for the finished surface, and without taking into consideration the various materials used and suggested for roads, there is only one fit to be used for good permanent results, and that is trap-rock. There is plenty of it in Massachusetts, and the only problem is to get it to the place where it is wanted.

With regard to thickness, I may state of later years I have been varying the thickness of roads according to the grades, making for them 8 to 10 inches thick for grades flatter than 1 foot in 100; 8 inches for grades between 1 and 4 in 100, and 6 inches for grades steeper than 4 feet in 100. This practice I have found gives uniformly good results.

The material for foundations may be of any durable stone; even water-worn sandstone is not objectionable, but if round they should be broken into parts, as such round stones are apt to work to the surface. In my early construction of roads I was very strenuous about

having trap-rock foundations, and even now mostly use that material for that purpose, as it is as handy as any other in the region in which I am constructing roads, but in sections of the State remote from trap-rock quarries I do not think it economy to haul the foundation-stone so far.

Under all circumstances the foundation-stone should be laid by hand, closely together, firmly wedged, with smaller stone on top, and this whole mass thoroughly sledged to a uniform surface.

And just at this point I want to lay special stress on the importance of sledging, wedging any foundation that is put in, for in my observation, in the ordinary practice of repairing country roads, it has been customary to use a great deal of field stone to help out these soft places, and with proper handling of the material used in such places, a fairly successful road might have been made. The result, however, was, after the layer of earth that had been put on had been washed or worn off, the road was very uneven and very much rutted, and somewhat of a torture to travel on. The cause of this was due to the fact that whereas, in wedging and sledging the foundation, you are enabled to distribute the load of a heavy wagon traveling over it, under the old way the concentrated weight came on individual stones, which sank and yielded an insecure or yielding bottom.

The thickness of foundation should not be less than 5 inches and as thick as the run of the material will permit. I built a mile of road with the foundation-stone taken out of an old fence. It was found cheaper to put them on the road as they were than to break them, and the result was the foundation averaged about ten inches thick. I must strongly allude, however, to the danger of using perishable stone in the foundation. Better have none at all than material liable to decay.

Having laid and constructed a good foundation for the

road, it is then ready for the top-course, which should be, except on very special occasions, of trap-rock. Before putting in the broken stone, it is better to spread a thin layer of loam or clay, just sufficient to fill the spaces of stone and make an even surface. Care should be taken not to have too much, as it does no good and harms the road. This packing, as it is called, is put there to prevent the bottom stones from coming up and mixing with the top-course, which they are almost sure to do without its interposition. The usual size for the broken stone is from one and a half to two inches in diameter, for on this part of the work depends the future smoothness of the road, and only men specially adapted to this kind of work should be allowed to do it. In my experience few men have or get the proper knack of spreading.

After the stone has been put on to the proper thickness and evenly spread, it should then be rolled, and here comes in again another point of discussion. Years ago it was considered imperative in the construction of a good road to have a steam roller. Experience, however, showed that a road could be constructed as well without it, and the trouble caused by the breaking of culverts, scaring horses and deterring travel generally within a mile of the steam roller led, first, to its condemnation by the community, and finally to its abandonment. No steam roller is used to my knowledge on any of the roads in Essex County, and I am glad of it.

A roller weighing about two tons, easily moved by two horses, is all that is necessary, costing, say \$150 to \$175, which should be purchased and owned by any community who are road-building.

The rolling of the top-stone should be sufficient to bring the stones down to a fairly uniform surface; another thin coating of loam is put on, and this is then repeatedly rolled, and the usual practice is on top of this to put on a coat of broken stone screenings, which is then rolled, and then travel is allowed to come on.

I wish to say at this point, that while the top coating of screenings is very desirable, where great economy is desirable, I think it can be dispensed with, for if it is possible to repair roads by covering them with a coating of three inches, and then rolling it properly and covering it with loam, I see no reason why new roads cannot be finished off in the same way. It requires a little more care, and you have to have a certain amount of travel to make it a success. I repaired the main avenues of Essex county in that way for years, and their condition was an endorsement of the method.

To do it properly, however, after the top stone is rolled and the coating of loam is also rolled, let the travel come right on. This makes ruts and furrows which a repeated rolling will remove, and let this be kept up till the surface is consolidated. The roller need not be kept in one spot all the time; let it go ahead and roll a new piece; come and smooth off an old piece, and so backwards and forwards, still however, progressing regularly forward.

When you have arrived at this period of your road's construction the general idea is that that is all, but I wish to say here, very emphatically, not yet. A new road like a new watch, wants watching and adjusting to get it into a new, permanent shape, and for the first year it wants to be looked after with some care. Ruts are apt to be formed, holes may appear, and these should be at once attended to. It is very easy, costs very little, but when this is done you will have what we all want and what this meeting proposes, a good road.

After the settling and adjusting have taken place, and everything is satisfactory, a road built as here outlined will last from three to five years for ordinary country travel. I have known a pavement always in good condition to run for ten years without repairs, and in my own case parts of the old Pompton turnpike, with fairly heavy country travel, had no repairs on them for five years, and were good at all times.

Now I come to another feature of the road question, which to my mind is more important than all others, and that is their repair.

While the road taxes in this State show that the repair of ordinary earth roads is an accepted fact, and money is voted therefor all over the State, when a pavement is laid down there seems to be a sort of recognized feeling that when it is built that is the end of it. Far from it.

Shoes wear out, wagons wear out, almost everything wears out by constant use, and so do roads, so that any organization formed for the construction of roads in any community should be continued for their repair. In repairing roads, I want to depart from the usual, accepted doctrine, and say don't patch. The old practice and theory of keeping men on the roads perpetually tinkering and mending is wrong in principal and expensive in practice.

If a road is built properly, it should wear uniformly, and when its thickness is so reduced that it is necessary to recover it with broken stone, let it be done in sections as large as you please, from a mile to half a mile, and it should be laid, spread and rolled in the same manner as described for the building. Of course it may, and undoubtedly will, be necessary to touch up stray places that under peculiar conditions are defective; these should be attended to, but as a general practice I say again, don't patch.

The remarks I made about screenings, in construction, are still more applicable to repairs. If you can afford it, put them on; they make a nice road, but are expensive, as a coating of loam costs \$30 to \$50 a mile and a coating of screenings from \$300 to \$400.

The foregoing remarks apply, as will be seen, only to what is known as Telford and Macadam roads, and if all communities will have these kinds of roads, and are willing to pay for them, so much the better, but the question will arise whether it may not be wiser in certain localities to use the materials nature furnishes to hand and try to get

along with them. To me it is rather a delicate matter, as, wedded as I am to this class of roads, I may be prejudiced against other kinds; yet I am willing to admit that certain kinds of gravel or slate, make good roads, yet they are not as good, and for a small portion of the year, especially in early spring, are far from perfect, and the difficulty arises that in a question of State policy all sections should be treated alike, and my special plea will be that these Macadam roads as described are standard types and everybody should have them if they can get them.

We now come to the important question of cost. Roads built in the manner I have described, cost, in Essex County, 60 to 80 cents a lineal foot, 16 feet wide, according to their thickness and distance the material has to be hauled, including foundations of quarry-stones. This would be \$3,000 to \$4,000 per mile. By using local stone for foundation and local help in hauling, and as much as possible local labor, and also reducing on many of the local roads to 14 feet, and even 12 feet, I think the cost throughout the State might be placed at \$2,500 per mile, provided due economy and wise administration are secured.

In the cost of repairs, a proper recoating of the surface can be put on in the same locality for from 20 to 25 cents per lineal foot, for a 16-foot road. This, by reducing the width and supposing a renewal every five years, would amount to about \$150 per mile on the average.

While these estimates of cost are based on present prices and present practice, the cost of the original avenues of Essex County was far greater; experience with that work was limited, the machinery had not been brought to the perfection that it has to-day for blasting or breaking the stone, wages were considerable higher, and experienced men in doing such work were scarce and highly paid; and furthermore, contractors wanted more profits than they expect or do get to-day, and incidentally in alluding to that word "Contractor" I do not think it out of order to bring that

point up at a meeting of this kind, and it is here that the pitfalls and troubles of road construction are most liable to be encountered. As is well known, and with all due respect to the men who follow the pursuit of contracting for small or large engineering structures and constructions, the contractor follows his business to make money, and not for the glory that might ensue from his work; and in no work of engineering practice is there more margin for departure from the contract terms, and the specifications of a contract without an absolute variation thereof, than in road construction. While my troubles in that line to-day are over, I have gone through experiences which should have turned my hair grey. To-day in our midst the practice is so crystallized, the ideas are so thoroughly understood, and the results of certain work, good or bad, so thoroughly known, that the question of having poor work done, rarely gives me any concern. The laying the foundations, the size of the broken stone, the spreading of the packing, and the finishing of the road, are all elements of weakness, if I may say so, in road construction, that a small departure from proper practice might not materially affect the ultimate result, yet an undue divergence would be fatal; and till the experience of the road contractors of Massachusetts is crystallized, all parties connected with road improvements in your State, whether they are engineers, contractors, or county or town officials, will have to go through the same ordeal. I allude to this more particularly in one aspect, and that is I have known incipient movements in road construction to be untimely nipped in the bud by the poor success of their first attempts, entirely caused by the undue rapacity, if I may say, of the contractor, or the negligence and ignorance of the engineer, and those having charge and authority over the work. This, of course, as I understand, is not peculiar to road construction, yet in my experience in many other forms of engineering work besides road building, I have found much more liability for this trouble in road work

than in any other. I would say at this time that one of the businesses and obligations, if I may so state it, of your Massachusetts road commission, as I understand on that commission you have an engineer, should be if possible to formulate what in their idea would be the best method of road practice throughout the state, and that then the commission should have legal authority to enforce it. I well remember the trials and vicissitudes that I went through in road construction on the one very simple practice of putting in packing. I, in early times, was an opponent to packing in roads; by packing I mean other matter outside of stone itself, either clay, gravel or sand; I thought that a stone road should be built entirely of stone, and so insisted, and had them built that way; yet when I found that other roads built with packing, judiciously used, were as good and in some respects better than my own roads, I could see no reason for adhering to one practice, when another was better. Fifteen years afterwards when the practice of packing had been so crystallized in our midst, an adjoining county was rent asunder, if I may say so, in a controversy as to whether their newly constructed roads should have packing in them; and to this day, while the packing was put in and the roads are a success, murmurs of dissatisfaction may be still heard. In New York State a law was even passed prohibiting the use of such material on the road in one county, and in my address to the Society of Civil Engineers I said with equal grace could the State Legislature pass a law regulating the treatment of billiousness by doctors. And while on that very question of legislature I would state that it is unwise, and almost impracticable in any proposed legislation for the State of Massachusetts to undertake to include in that legislation specific means and modes of construction that are and may be questions of engineering counsel.

The method of payment by the original Essex Road Board — and I presume this will be of interest, although

I do not say that it should be an absolute guide — was as follows:—The cost of opening the street, or widening it, and removing houses and other obstructions, was paid in cash to the owners, which was afterward assessed on the property benefitted, by the commissioners, and refunded in due time, subject, of course, to the inevitable contingency in all questions of assessments and taxes, that some didn't pay. The cost of the construction of the road was paid one-half by the county and half by the township through which each separate and individual piece of road passed. This cost was assessed in ten annual instalments, and placed in the tax levies, and collected as other taxes were. An amount of money footing up to about seventeen hundred thousand dollars was expended by the Road Board, seven hundred thousand of which was paid for right of way, and one million dollars for construction. Bonds were issued for the payment of the contractors, and right of way; a sinking fund was established by the receipts of the assessments, and by the payment of the ten annual instalments of taxes, and to-day of the one million seven hundred thousand dollars' worth of bonds originally issued, only a hundred and seventy-three thousand dollars is unpaid and not extinguished, and of this one hundred and seventy-three thousand dollars, I believe there is cash in hand in the sinking fund amounting to about fifty thousand dollars, The work of the Road Board itself as a whole is practically concluded, and has been for ten years; there are certain gaps which have been left undone for the reason that communities through which they were to pass were unwilling or unable to pay the tax necessary for their construction. As time goes on, however, these gaps will disappear; the necessity of good roads arising and being appreciated, will cause sentiment in their favor undoubtedly, and while the amount is small, it may take some years to finish it; I am now constructing a mile and a half in the lower part of the county. It must not be supposed

that the entire work of hard roads in Essex County was done by the Road Board; the example set by that commission was immediately followed by the several local committees, quickly or slowly, as their personal equations dictated. The city of Newark made an attempt to build Telford roads through its streets, but the poor construction, bad results from negligence and carelessness, put a veto on further extension in that line, and after 1875, Newark city built no more of them, and is now centreing its efforts in laying the regular city pavements. The city of Orange,—and, bye the bye, I ought to say the city of Orange was the pioneer municipality in road-building in New Jersey, having started to Telford the main streets as early as 1869—the city of Orange slowly and steadily has been building roads, until to-day very few of its streets are unimproved. The township of East Orange has done the same thing, with the same result. The township of West Orange made a bold dash in 1872, spent two hundred and fifty thousand dollars, and created a complete system of thorough communication through its own limits; the effort it made then practically exhausted it, for since, it has built no more, and the law under which it acted providing that the township should pay the whole cost of construction, created a large debt, which it is now struggling under. The city of Orange and the township of East Orange assessed the cost of the whole of their pavements on the property benefitted, and the movement was entirely spontaneous among its inhabitants, who forced the matter to an issue with the knowledge that they paid for it themselves. This, of course, is exceptional, but it shows the feeling on the road question. After citing these three examples, a long lapse of years passed before the other communities tackled or ventured to tackle the road problem in its proper sense; meetings were held, talk was made, literature was consulted by the different communities, but practically nothing was done until about 1883, when there seemed to be a general awakening

along the line for road work. Montclair township started in, Bloomfield township started in, built roads by appropriating so much money in their tax levies each year, and built so many miles, as far as the money would go. Belleville township five years ago bonded itself for fifty thousand dollars and built a complete system of roads at once through its limits. Franklin township followed suit, and built another system of roads through its limits. I may say here that South Orange village has also been quietly and slowly building Telford roads, assessing the cost on the property. The rest of the townships of the eastern slope of the Orange township made no strong movement, except to appropriate money and buy stone, and spread it on the road, and let nature and the wagon travel take care of it; some of them turned out fairly successful, others are mere parodies, still the intent and idea was there, and after going through a course of instruction and paying the bills, it will be found they had better started a complete system at once, and had good roads, permanent and proper in their construction, for a great deal less money. In all, I should say, approximately speaking, there are about two hundred miles of Macadam and Telford in Essex County, outside of the limits of the city of Newark, and the movement has not stopped. In my own township where I live, with a population of ten thousand people, twenty-five thousand dollars a year is annually raised for expenditure on and repair of roads. This may astonish a rural community, but still it is a fact; the money is cheerfully raised, and willingly paid. Bloomfield, the next township, raises eighteen thousand dollars a year for the same purpose; and of course it is wiser for any community that can afford it to follow that practice, than to bond itself; but as Montclair is bonded for something else, that argument could not very well apply to that township.

The main argument used by a great many people in advocacy of good roads, is the increased value of the prop-

erty benefitted by their construction. In my opening allusion to the road question, I alluded to the varying conditions of life that are effected by good or bad roads and while I do not deprecate the argument of dollars and cents as an inducement for road construction by the increased value of land, I think the other benefits have as much weight, and I do not consider the mercenary view paramount, but still the fact is patent, and nobody knows it more than the farmer, that his land is worth more with a good road to haul his produce to market, than it would be without; this needs no argument, and I will allude to it very slightly. Still, for all that, a few figures on this phase of the road question may be interesting, and while I have not and cannot lay before you a complete set of tables for that purpose, as that would be tedious and somewhat incomprehensible, yet a few deductions may be of interest. In looking over the valuations of the different municipalities of our county for the last twenty-five years, I find that there are paramount issues that regulate values above and beyond any local questions of either development or growth; for instance, from 1867 to 1875 was a period of large, and I may say, abnormal increase in valuations; from 1875 to 1880 was a period of sharp and decisive shrinkage in valuations, due from the panic and national causes; from 1880 to date has been a slow, steady and persistent growth in valuations due to the slow but steady increase in population and wealth. As the road improvements in Essex County were began years before the panic, and continued through the panic, I can gather no absolute information from the figures as to the definite increase of valuations due to the road itself: our system was general, and as much as could be, affected all the population of the county at once; and as the increase to 1875 was general, the decrease to 1880 was general, so the effect of the county roads on the different townships in a monetary sense cannot be de-

terminated. If, however, I look further, and seek for information as to the increase of valuations due to the local improvement of roads, I get plenty of matter for consideration, and also strong arguments in advocacy of good roads. I find, for instance, that the city of Orange beginning in 1868 with its road improvements and continually building them up to date, has increased its valuation from three millions in 1867 to seven millions and a half in 1892; while South Orange its neighbor, with a fair road improvement, but merely in one part of it, has increased from one million, eight hundred thousand in 1870 to three millions in 1892; and Clinton township a neighbor to South Orange with no road improvements worth speaking of, had a valuation of one million seven hundred thousand in 1870, and has only a valuation of one million seven hundred thousand today. I find that the township of Belleville, which had a valuation in 1875,—I take this date because just prior to that a part was cut away from it, and formed a new township,—in 1875 Belleville had a valuation of one million three hundred thousand, and in 1890 had the same valuation: in 1890 however, it put down a complete system of roads in the township, and its valuation immediately sprang from one million three hundred thousand to one million five hundred and seventy-eight thousand. This is a conclusive argument on road question. I will here interject the point that in Essex County no railroad improvements, beyond one short section of a mile, have been made in the whole of the County in twenty years. The township of Franklin had a valuation in 1875, just after its creation, of seven hundred and sixty five thousand dollars, which was reduced in 1890 to six hundred thousand dollars; this was caused by the abandonment and failure of two or three large mill properties, and a decrease in the valuation resulted; but in 1890 it initiated and constructed a system of roads, and in 1892 its valuation jumped from six hundred thousand

and to seven hundred thousand dollars. The township of Montclair that had a valuation in 1870 of one million seven hundred thousand dollars, slowly increased to two millions and a half in 1875 ; from 1885 to date, it has steadily constructed its system of roads, and its valuation has increased, until in 1892 it is over five million dollars. The township of West Orange that completed and finished its roads between 1870 and 1875, increased in valuation from two million three hundred thousand in 1870, to three millions in 1875. In 1892, it is three millions still. The township of Livingston, with absolutely no road improvement at all, had a valuation of five hundred and thirty-five thousand dollars, in 1867, and has a valuation in 1892 of five hundred and ninety-five thousand dollars ; practically no increase in twenty-five years. The township of Caldwell, which forms nearly one quarter of the area of the County and is entirely rural, had a valuation in 1867 of one million four hundred thousand, and has a valuation in 1892 of one million five hundred thousand ; no roads except the county road had been built in that township, until the year 1891, when they appropriated ten thousand dollars, and spent it on roads, and curious to say created such a commotion among its inhabitants, that literally tore it apart, and the next year it was divided into three governments, namely, one borough, the township Verona, and the original township of Caldwell. The next year they did not raise any money, and they are now actively canvassing the road question, and in the next two years will undoubtedly do good work.

The township of Milburn that had a valuation in 1869 of one million, had in 1892 a valuation of one million three hundred thousand ; the road improvements in this township are not large, and are mostly confined to individual enterprise in certain restricted portions, and are not paid for by the township itself, but the increased valuation is entirely in the district affected by the roads construction.

We here see the undeniable fact that communities that have steadily and persistently built roads for a period of years, have steadily increased in valuation ; we also see that communities that have not built roads have not increased in valuation ; we also see that where communities built roads and stopped, the increase of valuation stopped when they ceased building the roads ; we also see that the community that had its valuation stationary for a period of years, had its valuation immediately and remarkably increased on the construction and completion of its system of roads, and I can deduce no stronger argument on the monetary question of road construction, than these very facts and figures that I have here outlined. Of course, it may be urged that there were other influences at work in the growth or stationary condition of any community ; railroad communication, horse car communication, soil, healthfulness and all those matters should be and have to be taken into consideration as elements of growth ; yet when you consider that Essex County in size is only about twelve miles square, the healthfulness of one particular place over another cannot be much marked in that distance, and as to the availability of one place over another for residence, that cannot be much marked either ; and we are forced to recognize the value of these figures and the deductions I have drawn from them, without desiring to be considered partial or straining at results, in advocacy of road improvements. There is one point, and it is a mighty strong point too, on the road question, which I feel more strongly about, and more inclined to adduce arguments and figures, than the land valuation (though of course land valuation is affected by this point I am going to allude to), and that is the increase of business, and by business I don't mean one particular business, I mean business in general of the whole community through which these roads pass. It is impossible for me to go into all the details and ramifications and cite the different business interests that are affected by good

road construction, but the conclusions are really patent to everybody. The difference between the business conditions of a community which has its modes and means of communication paralyzed for a certain portion of the year, and another community that has free access, and free ways at all times, is so obvious to the ordinary mind, that much stress is needless on my part. My more particular attention to this question has been directed to the increase of the farming industry in Essex County, due I am satisfied to the roads that have been built. To cite an instance of this, I would say that before the road movement began, there was one road known as the plank road which ran out three miles from Newark, and could be travelled at all seasons; talking with a farmer at that time, who lived along it, he was expressing gratification at the prices at which he sold his hay in the city of Newark. He said that he waited until the rest of the roads in the County were impassable, and then he ran it down the hard road, and, in his quaint way, said he got two prices for it. Now this was very nice for that individual farmer, but the principle of the greatest good to the greatest number was hardly applicable in this case. Somewhere about 1860, I think, the city of Newark built a market, and in front of the market left a piazza, or open space of about one hundred feet square for the farm wagons that came from the country to sell their produce; it was rare at that time to see the piazza fully occupied; however, when the good roads began to be a fact, it was astonishing then to see the difference. The piazza soon got filled, the wagons kept piling in, and increasing in numbers till the whole of the main street for three quarters of a mile from the market was occupied every morning till nine o'clock with farm wagons and farm produce, which was sold along the sidewalks. Under the circumstances this practice was tolerated until it got to be such a nuisance, as the property owners said, to the other business interests, that the courts were pleaded to interfere,

and the final result was that the city of Newark had to spend three hundred and fifty thousand dollars to furnish extra market facilities for the produce merchants, who brought their product and farm produce from the districts outside the city of Newark. Newark City paid it cheerfully, as the difference in costs of the material sold was so remarkable, so much less, that the payment of that sum of money was actually a good investment to the county at large. Other matters might be cited, but this one point speaks volumes for itself: if I had time and opportunity I would liked to have hunted up statistics of the difference in the number of horses proportionate to the inhabitants owned in Essex County in 1890, and what were owned in 1870; also the number of wagons, and I am satisfied without knowing the real facts that the figures would prove equally convincing as to that line of industry. There is one thing I am very free to say, and I think it impossible for any one of intelligence to gainsay, that no man would ever wish for Essex County, N. J., to relapse in the slightest degree to the original mud, dust and mire, that it experienced and suffered under during the preceding year prior to these road improvements.

While I have so far detailed the experience and practice in road work in Essex County, it must not be supposed that the rest of New Jersey was idle or lying passive. The county in the north that I alluded to, has initiated, and is progressive with its county system of roads. The county of Union, south of Essex, has done the same thing, only, as I have said, in better shape. The county of Hudson, in which Jersey City is situate, is now building a system of boulevards and driveways, which will be an ornament, besides a great improvement, to its, until now, muddy streets. Bergen County, on the northeast, has not yet been able to brace up, if I may say so, and construct any county roads; but the different townships and towns have taken the matter in hand themselves, and have built and are building

complete systems of their own. Outside of that, with the exception of one township in Camden County, New Jersey is in the same condition as the rest of the United States; and until the States—and I may say here, that the State of New Jersey is the first State in the United States to incorporate a road law as a State measure, and afford State help in the construction of its roads—and until, as I before said, the State law was passed, no very strong movement for road improvements had been apparent. Last year one or two attempts, which proved fruitless, were made to start in Burlington County, Monmouth County, and Middlesex County; public sentiment not being educated up to the required standard, the county officials refused to do their part, and as far as Monmouth and Middlesex Counties are concerned, nothing was done. Middlesex, however, at the last moment, jumped in the gap, and has been the first county to take the help that the State has offered, and put it with the money that she herself has raised. The movement, however, is progressive; there has been a State Road Association formed, with members from all parts of the State; meetings are held, sentiment is being created, and I doubt not, that in the near future, the southern and western part of New Jersey will have as good and as ample road conveniences as the section that I have heretofore described has enjoyed. As I understand, the State of Massachusetts of itself, has taken hold of the road question as a State measure, and appointed a State commission for the purpose of suggesting and outlining future legislation and action on the part of the State, and its component parts. A brief resume of the road legislation of New Jersey, might be advantageous and of interest. As originally stated, the pioneer law of New Jersey was known as the Essex Public Road Board law, applicable only to Essex County; within a year from the passage of that act, Hudson County, the county on the east, between it and New York, had also a County Road

law passed, but from its disordered condition of finance, or from a lack of sentiment endorsing any such movement, the law was allowed to lapse, or the county never availed itself of its privilege, and nothing was done. Some years afterwards, subsequent to the amendment to the constitution, prohibiting special legislation, a general law was passed in the interest of Hudson County, giving it power similar to what it had under the original law, known as the Boulevard Act. That law provided for a vote of the people to be taken before its being efficacious. If I remember rightly, a vote was taken and carried, but the matter was thrown into the courts, and whether it was pronounced unconstitutional, or what the decision was, I forget, but the result was, nothing was done under that act. Some years after, another act was passed by the same county, and about three years ago, a movement was made, and the necessary legal sanction given, and the plans have been promulgated, surveys have been made, and I believe that the work is under contract. Between 1868 and 1875, before the amendment to the Constitution, individual townships had special legislation passed for their benefit, to enable them to Telfordize their roads, and pay for them in the way the law designated, in accordance with the idea and sentiment of each community, varying, of course, in different townships and cities. Under these special laws, West Orange did its work; the city of Orange, being a city, did its, and the township of East Orange and village of South Orange. Then there was nothing done in legislation until about the year 1885, when a general law was passed, authorizing townships to improve their streets; this is a very admirable law, and has been availed of by a great many townships, and has proved very successful in its results. The provisions in it are stringent; they require that the consent of, I think, two-thirds of the assessed valuation shall be given to make an application to the town authorities for a vote to be taken by the peo-

ple, whether they shall bond themselves for that purpose. So carefully guarded is the law in that respect, that it practically requires an almost universal sentiment in the community for the work to be done; but I have yet to hear of any township making a movement in that direction, but has accomplished it; probably sentiment was so ripe that the result was inevitable. A number of townships have availed themselves of the law, and a number are now agitating the question among themselves. A law also, applying to boroughs, which are smaller municipalities within townships, was passed, with the same idea and same restrictions; in one or two cases this law has been availed of. In 1886, the law known as the General County Act was passed; this law authorizes the Board of Freeholders, a body similar to the Supervisors in New York, and the County Commissioners in the State of Massachusetts, to take certain roads, which in their judgment are wise, and declare them county roads; having filed maps, recorded such declaration, the freeholders are empowered to maintain and improve them as county roads, and macadamize them, and do everything that in their judgment is necessary for proper and good travel; the freeholders are authorized, up to a certain limit mentioned in the law, to issue bonds for that purpose. The work is done, and the cost of that work is assessed, a certain sum, namely, two-thirds, upon the county, and the balance upon the township in which the work is done. That known generally as the Union County law, has been availed of by Union County and Passaic County, two counties I have alluded to, and Bergen County has been trying for a number of years to act under the same law, but till within the last year or two, the officials in control have not had the courage, or endorsement of the community sufficiently strong, to cause them to go ahead; I believe now they are building small sections of roads at the county expense, but I am not sure of that.

The next general legislation on the road question is what is known as the State Aid Act, and is the law I alluded to when I stated that New Jersey was the first State in the Union to grant State aid to roads. This law provides that whenever the Board of Freeholders in any County have declared their intention of causing any particular road to be macadamized, under certain conditions and rules and regulations, they shall declare it a county road, and shall certify to the State Board of Agriculture their action, with the bids on such work ; that on the endorsement of the action by the chairman of the State Board of Agriculture, the State shall pay one third of the cost, the balance being paid by the County, who are authorized to tax the County under the general tax regulations. The state is limited in its expenditure in one year to seventy five thousand dollars, and that one third represents a road expenditure under the State Aid Act, of about two hundred and twenty-five thousand dollars for one year. A supplementary clause in that act provides, and this, while it seems to be secondary in the law, is really the main feature of it, when a majority of the owners on any section of road, not less than one mile long, petition the Board of Freeholders, and in their petition guarantee to pay ten per cent. of the costs, the Board of Freeholders shall then get bids, and submit the same to the chairman of the State Board of Agriculture, who shall then approve or reject, and the State will then pay thirty per cent. the cost of this road is then divided up, owners ten per cent.; county sixty per cent., and the State thirty per cent. The law is a recent one ; the original passage in 1891 was hampered by the sanction being given to the Commission of Agriculture, the anticipation of the appointment of which was not realized, and the next year, in 1892, it was amended, giving the powers to the chairman of the State Board of Agriculture, and under his auspices, and energetic efforts, whatever has been done in

the State at large, is due to his effort ; and as I previously stated, while the thing is in its infancy, with the movement of sentiment and progress through the State, it will become very popular, and the seventy-five thousand dollars will be so sought for and grabbed after, that the State in future years will consider three hundred thousand dollars not too large a sum for that specific purpose. The enormity of the scheme of State road construction, may be conceived, when I say that the State of New Jersey, which I think is a little smaller than the state of Massachusetts, has eighteen thousand miles of roads in it, and I presume it will be fair to consider that the State of Massachusetts has the same ; and the enterprise that undertakes to improve, or try to improve such a vast net work for inter-communication is bound to be opposed, and hampered by opposition and, as I call them, kickers, everywhere.

In conclusion I wish to claim no particular, or in fact any, advantage in the roads of New Jersey, or the system of their construction, or the laws under which they were built. I recite here in my own way what has been done, what has been thought of doing, and probably what may be done in the future. This experience is valuable, and while your State of Massachusetts may not follow, and may not be inclined to follow the lines of work either in legislation or construction of the State of New Jersey, yet, the experience that State has gone through must be of great value to your State, and, by a study of that experience you may avoid the mistakes and troubles that New Jersey has undergone, and by avoiding these mistakes and troubles, money, which is the basis of all this work in any shape, and under all circumstances, will be and must be saved.

